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Mapping of air borne dust in a surface coal mine – a GIS application

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ABSTRACT

The air borne dust particulate beneath 10μ size causes foremost health evils to the miners and peoples residing nearby areas of a surface mine. So it is major area of concerns to the Mine Management as well as Regulatory bodies like DGMS. Very few R&D work have been undertaken on dust concentration at prominent mine locations. There are no such guidelines about the distance of rehabilitates in relation to an open cast mines in India. In this project, an attempt has been made to depict a digitized raster map of mine related to dust concentration with the help of "ILWIS 3.7" software so that if pointer is clicked at any point within the digitized area it gives instantly the name of location as well as projected concentration of dust at that point which has been developed out of considerable sample size of authentic field based data recorded at prominent mine locations. All the dust concentration data has been recorded with the help of "DUST TRAK MONITOR".

Key words: Aerosol, Ilwis 3.7, health hazard, digitization, raster map

1. INTRODUCTION

Dust is defined as the fine particles (Generally below 100μ) of organic or inorganic substances suspended in atmosphere. These airborne particles creates environmental nuisance and causes health hazard during mining activities. The plying of HEMM in surface mines is the major cause of dust generation in mines premises. Dust concentrations have been measured (below 10 micron) at different prominent locations of a surface coal mines in Eastern region of India. The indispensable aspire of project is to stumble on the concentration of dust at different point of time having varied distances from its point of generation. Generated dust propagates in all direction and creates an assortment of problem in that area especially to the health of miners and those people living in the surrounding area. The dust concentration measurement has been done with the help of "TSI Dust Track Aerosol Monitor" and digitized dust concentration maps are created with the help of ILWIS 3.7 software. On measurement of dust concentration at various locations with respect to its point of generation it would be easy to allocate the distance where the person can live without much dust hazards.

2. WORK ELEMENTS

In order to accomplish this study the allied work programme is divided into a number of following stages:-

- Record of dust concentration with the help of "Dust Track Aerosol Monitor" (a portable, battery-operated laser photometer having data logging capability) has been done at different prominent mining locations like-
 - Near Shovel, Dumper and Drill (during pre and post blasting period).
 - Near mine office, Workshop & VTC, Time office, Washery & Power plant, First aid centre, Rest room, Magazine, CISC Camp, Mine office etc.
 - Habitable mine area including surrounding village.
 - Haul road (before and after water spraying).
 - View point of the mine.
 - Coal bench, Overburden bench
- Dump and Back filled areas
- Actual mine plan has been digitized.
- Conversion of digitized map into raster map.
- From the recorded data bar chart have been drawn to have a comparative idea on dust concentration at different locations (Mukherjee, 2004).

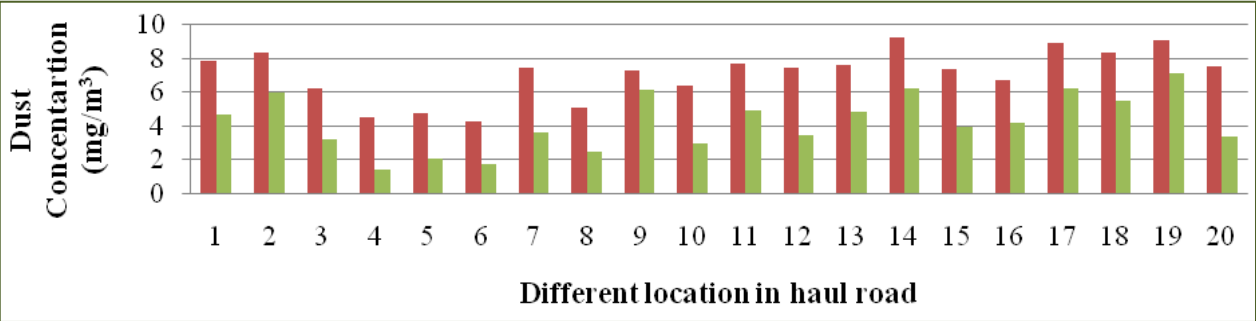
3. PREPARATION OF WORKING PLAN

The complete work programmed as shown below has been divided in two parts

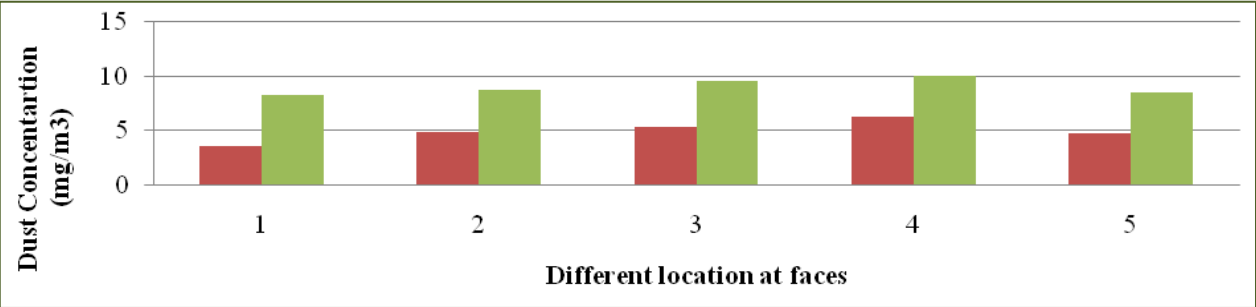
A. Plotting of bar chart to get a comparative insight on the dust concentration at different locations (Bar chart 1 to 7)

B. Preparation of flow diagram to formulate different maps with the help of ILWIS 3.7 software (Figure 1).

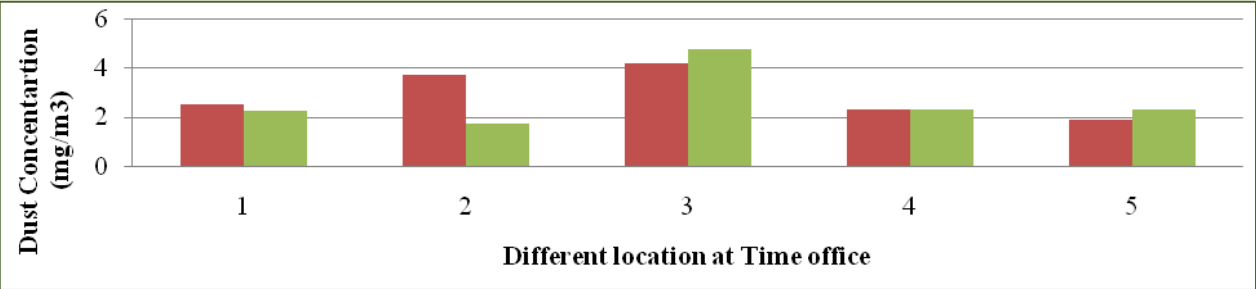
The length of haul road, working faces, mine office, and other prominent places have been distributed in different mine locations. It has been observed that the working is concentrated in different faces which have been shown in the chart. Though dust concentration and their comparison has been done for various mining positions but due to paucity of spaces, the dust concentration and its analysis in the form of tables charts have been shown for haul road and working faces only. In the said study major emphasis is given on haul road where 20 numbers of readings (pre and post spraying period) are by the TSI



Bar-chart 1
Dust concentration before and after spraying on the Haul road



Bar-chart 2
Pre-blasting and post-blasting concentration of dust in faces



Bar chart 3
Pre-blasting and post-blasting dust concentration at different locations at Time office



Bar chart 4
Pre-blasting and post-blasting dust concentration at different locations at Rest station

Dust Trak Recorder and red and green color bar denotes the pre and post blasting dust concentration in different location of a surface coal mine. Dust concentration has also been observed in each face to get an idea of dust liberation, accumulation and propagation (Appleton et al. 2006). The dust concentration at haul road and coal faces are presented in the form of table and charts while mapping part is done by the ILWIS software.

3.1. Scanning of mine map

The work starts with scanning a hard copy of a plan of a surface mine. The scanned image of the plan is in the Windows bitmaps (.BMP) format. The file is then converted into Tagged Image File Format (.TIF) with help of the Paint tool in WINDOWS operating system.



Bar chart 5

Pre-blasting and post-blasting dust concentration at different locations at First Aid centre



Bar chart 6

Pre-blasting and post-blasting concentration of dust at different locations at Washery and Power Plant



Bar chart 7

Pre-blasting and post-blasting concentration of dust at different locations at Workshop & VTC

3.2. Importing & Geo-referencing

3.2.1. Import

After conversion of the file into Tagged Image File Format (.TIF), the file is imported in ILWIS Software package. The imported file (.TIF) is converted into Raster Map (.MPR).

3.2.2. Create Co-ordinate system

A coordinate system defines the XY-coordinates or Lat-Lon-coordinates in maps which are directly used by point, segment and polygon maps; a raster map uses a georeference which uses a coordinate system. The selected coordinate system type is "Projection". Maps with different coordinate systems and different projections can be transformed into one another. One coordinate system can be used by many maps. After the map is imported in ILWIS, then a co-ordinate system based on Latitude and Longitude will be created. After that declaration will be made about the projection system, datum and ellipsoid. The maximum (X, Y) and minimum (X, Y) is required to enter (Figure 2).

3.2.2.1. Projection System

Projections are designed to solve the problem of drawing objects which are located in a spherical coordinate system (on the earth's surface) in a planar coordinate system (XY-coordinate system), i.e. on a piece of paper. The problem can be compared by making a whole orange, halve an orange peel or part of an orange peel appears flat. The selected projection System is Polyconic.

3.2.2.2. Datum

A geodetic datum defines a reference ellipsoid for a particular region, oriented to the landscape, with an 'initial point' of reference on the surface. The 'initial point' is assigned latitude, longitude, an elevation above the ellipsoid, a direction of the vertical, and the azimuth of a point in the vicinity (to fix the North). Once a datum is adopted, features on the ground in a given area can be mapped relative to the adopted ellipsoid and the adopted 'initial point'. The selected datum is Indian (India, Nepal).

3.2.2.3. Ellipsoid

For large scale topographic maps such an ellipsoid must be chosen. For a number of projections available in ILWIS, an ellipsoid can be selected. Spherical projection algorithms are provided for certain less current projections and projections for global atlas maps. In addition, with small scale maps, the flattening is negligible and a spherical model is preferred. The selected ellipsoid is Everest (India 1956).

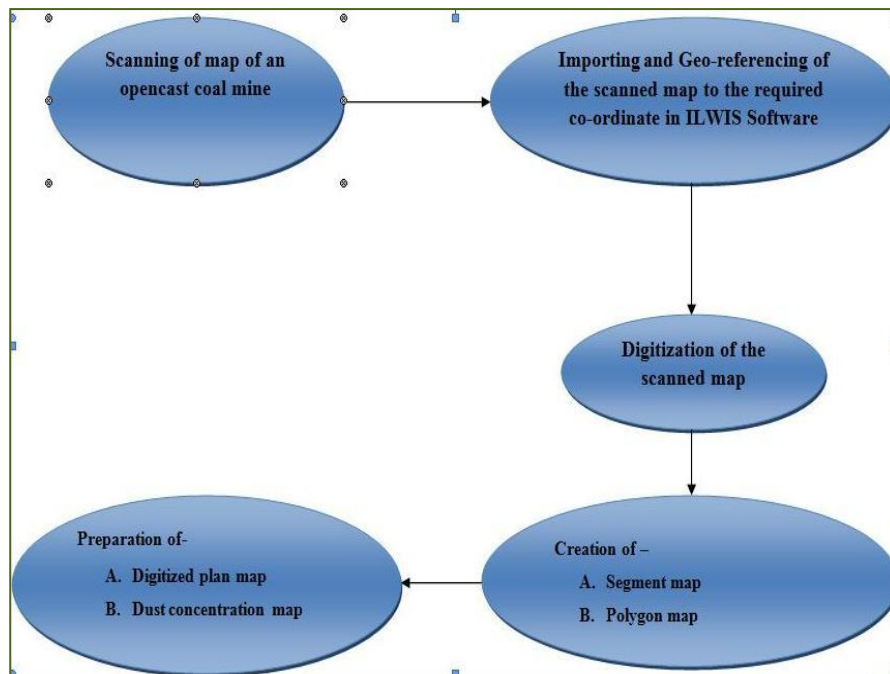


Figure 1
Flow diagram on ILWIS 3.7

very useful function. Here data layers are combined and new information is derived, usually by creating features in a new layer. At first, raster map (.MPR) of the mine is to be shown in the ILWIS window. After that we have to create a segment map over the displayed map. Then digitize the specified area or line. We have to give some name to these maps. In this way digitization finished with completion of the lease boundary map, Mine boundary map, Coal bench map, Overburden map, External dump map, Village area map, Rest station map, Time office map, VTC and Workshop map, Washery and Power plant map etc then we prepared the dust concentration map by overlapping (Organiscak et al. 2005).

4. CONCLUSION

Apart from mining statues a number of resolutions have been made on dust monitoring in different National Safety Conferences where study on dust related matters have been made mandatory. Keeping this in view it is worth to mention some effective measures which are liable to reduce generation and dispersion of dust at mine premises.

- Water spraying with mobile and fixed type sprinkler.
- Mixing of road dust control chemical.

3.2.3. Geo-referencing

A georeference defines the relation between rows and columns in a raster map and XY-coordinates. The location of pixels in a raster map is thus defined by a georeference. It is advised that raster maps of the same area use the same georeference. A georeference uses a coordinate system which may contain projection information. Polygon, segment and point maps merely use a coordinate system. A georeference is a service object, usually for several raster maps (Thompson et al. 2002). The selected georeference type for the project is "Georeference tiepoints". It is a non-North-oriented georeference to add coordinates to a satellite image or to a scanned photograph, a scanned map, etc. without using a DTM. The tie points given for the map is given in Figure 3.

3.2.4. Create Domain

A domain consists of a set of class names or IDs, a range of values, colors, etc. and it uses a certain representation which defines the graphical representation of a map, e.g. the coloring. The classes may be dust concentration etc.

3.3. Digitization

Digitization is done after overlaying the maps upon one another. Overlay function in ILWIS is a

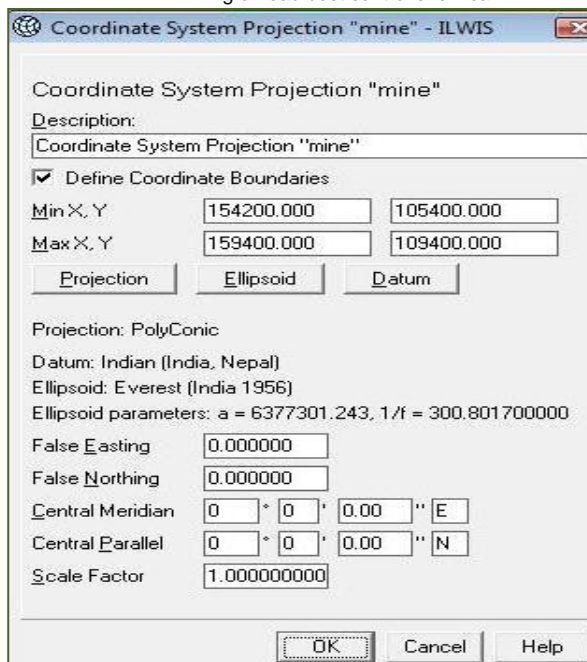


Figure 2
Pop up window of Coordinate system creation

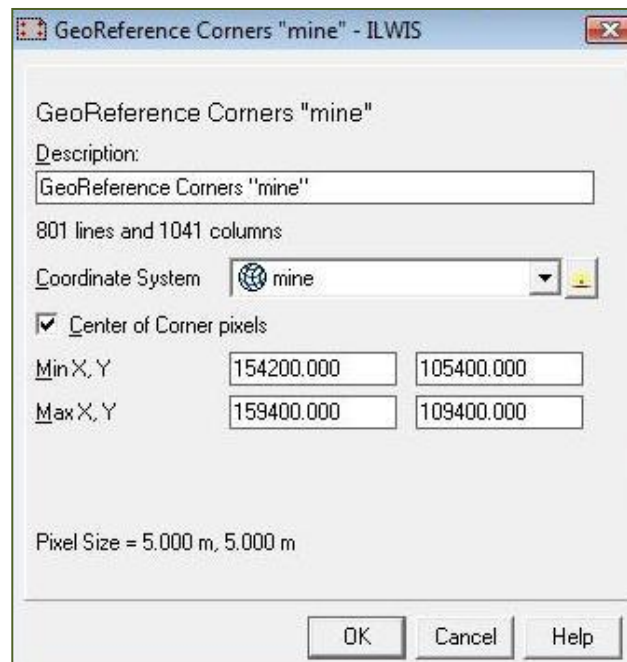


Figure 3
Pop up window of Georeferencing creation

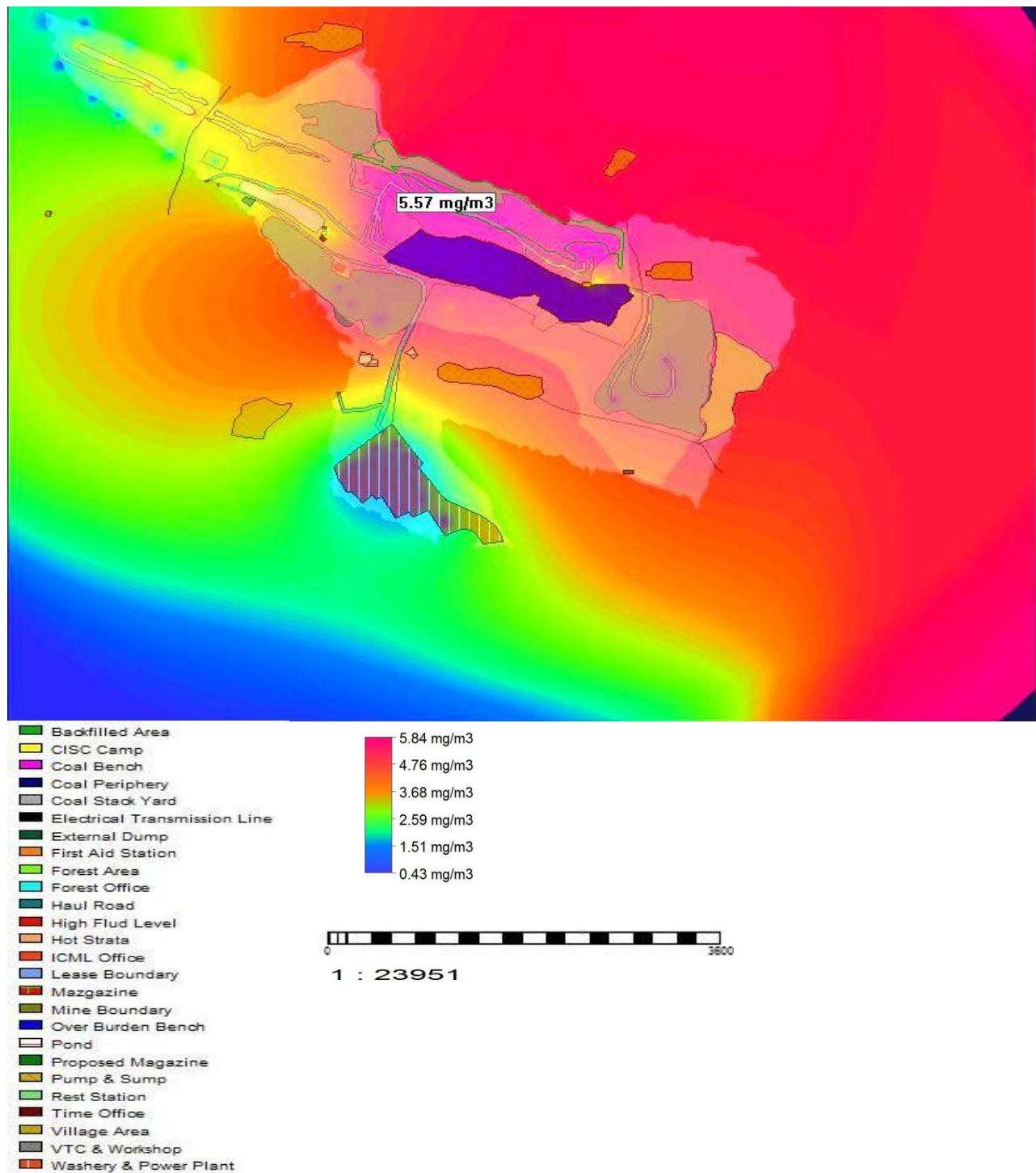


Figure 4
Dust concentration map

- Proper maintenance of haul roads and cleaning of spilled material.
- Proper design of vehicles for low dust generation.
- Dust control through tree plantation.
- Personal protection devices- Dust respirator and Dust helmet.
- Suppression of mine dust by using Ionizer.

5. RECOMMENDATION

Development of a model of dust concentration which can predict the amount of dust exposure to the miners and people residing in nearby mine areas and recommends the possible solution. In this project, intensive work has been done to collect the data as concentration of dust ($<10\mu$ size air borne particle) at different locations with respect to different parameters. A digitized raster map of mine has been created with the help of ILWIS 3.7 software which can tell the amount of dust

concentration at any point within the mine or nearby area of the mine for particular date and time and different bar-charts has been made for the comparison so that it can understand that whether blasting pattern is suitable or not, explosive is suitable or not, frequency of water spraying is proper or not for minimum generation and desperation of dust. By using the above dust concentration map and bar charts following are the things which can be done

- To measure the approximate quantity of dust exposure for any miner working at a particular site so that mine management can take necessary steps like periodic rotation of workers, spraying of water etc.
- To measure the safe distance of rehabilitation for miners and people residing nearby mining areas.

To determine the frequency of water spraying to a particular location.

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REFERENCES

1. Appleton TJ, Kingman SW, Lowndes IS, Silvester SA. The development of modeling strategy for the simulation of fugitive dust emissions from input quarrying activities a UK case study, *International journal of surface mining, reclamation and environment*, 2006, 20, 57-82
2. Mukherjee M. Estimation of fugitive dust emission in open cast mines, *Journal of mines, metal and fuels*, 2004, 32-34
3. Organiscak JA, Randolph RW. Characteristic of fugitive dust generated from unpaved mine haulage roads, *International journal of surface mining, reclamation and environment*, 2005, 18, 236-252
4. Thompson RJ, Visser AT. Bench marking and management of fugitive dust emission from surface mine haul roads, *Mining technology*, 2002, 111